# guidelines for design & operation of refuse incinerators in alberta

Alberta

In accordance with Part 1, Section 4 of the Clean Air Act
(General) Regulations being Alberta Statute 216/75,
The Department of Environment hereby issues

# GUIDELINES FOR DESIGN AND OPERATION OF REFUSE INCINERATORS IN ALBERTA

Prepared By:
Air Quality Branch
Standards and Approvals Division
Environmental Protection Services
February, 1983

## FOREWORD

These guidelines, for the design and operation of incinerators in Alberta, are a consolidation of existing practices and procedures used by Alberta Environment during application reviews. They apply to all new and existing incinerators. Permits to Construct or Licences to Operate will be issued under the Clean Air Act when the provisions of these guidelines have been considered and the appropriate standards have been complied with.

# TABLE OF CONTENTS


| SECTION | | PAGE |
|---|---|---|
| 1. | INTRODUCTION | 1 |
| 1.1 | Authority | 1 |
| 1.2 | Intent | 1 |
| 1.3 | Scope | 1 |
| 1.4 | Provision for Updating | 1 |
| 2. | INCINERATION TERMINOLOGY AND DEFINITIONS | 2 |
| 2.1 | Terminology and Definitions | 2 |
| 3. | GENERAL INCINERATOR DESIGNS AND COMPARISONS | 6 |
| 3.1 | Incineration Process | 6 |
| 3.2 | Principles of Solid Waste Combustion | 6 |
| 3.3 | Types of Incinerators | 6 |
| 3.4 | Design Characteristics of Single Chamber, Multiple Chamber and Controlled Air Incinerators | 7 |
| 3.5 | Design Comparison | 12 |
| 4. | GENERAL REQUIREMENTS FOR INCINERATOR APPROVAL | 14 |
| 4.1 | Acceptability | 14 |
| 5. | INCINERATOR EMISSION GUIDELINES | 18 |
| 5.1 | General | 18 |
| 5.2 | Specific Emission Limits | 18 |
| 6. | ASSESSING INCINERATOR COMPLIANCE | 19 |
| 6.1 | Visible Emissions | 19 |
| 6.2 | Particulate Emissions | 19 |
| 6.3 | Gaseous Emissions | 19 |
| 7. | INCINERATOR EMISSIONS TESTING | 20 |
| 7.1 | General Requirements | 20 |
| 7.2 | Visible Emissions | 20 |
| 7.3 | Particulate Emissions | 20 |
| 7.4 | Gaseous Emissions | 20 |
| 8. | APPLICATION PROCEDURE FOR A PERMIT TO CONSTRUCT AND A LICENCE TO OPERATE | 21 |
| 8.1 | Permit Authority | 21 |
| 8.2 | Licence Authority | 21 |
| 8.3 | Exemption of Oilfield Incinerators | 21 |
| 8.4 | General Requirements | 21 |

TABLES

1. Classification and Design Data of Wastes to be Incinerated ..... 5
2. Quantities of Waste Produced (Sizing and Classification Guide) ..... 16
3. Typical Densities of Refuse ..... 17
4. Volume of Some Common Waste Collectors ..... 17

FIGURES

1. Single Chambered Incinerator ..... 8
2. Multiple Chamber (Retort) Incinerator ..... 9
3. Multiple Chamber (In-Line) Incinerator ..... 10
4. Controlled Air Incinerator ..... 11
5. No Heat Loss (ADIABATIC) Temperatures of Cellulose Combustion with Excess Air Variations ..... 13

APPENDICES

Appendix A — Application Form For Approval of Incinerator Installation ..... 22

# 1. INTRODUCTION

## 1.1 Authority

The Clean Air Act and regulations require that operators of certain types of incinerators receive a Permit to Construct and a Licence to Operate. The Clean Air Act and Regulations are available from the Queen's Printer for a nominal fee.

## 1.2 Intent

This publication is intended to familiarize incinerator manufacturers and prospective incinerator owners with Alberta Environment's procedures for approving the design and installation of incinerators and to promote a consistent approach towards the prevention of air pollution from the burning of waste materials.

## 1.3 Scope

Incinerator design parameters and operating procedures discussed in this paper apply to units that burn waste types No. I, No. II, No. III and No. IV. The basic principles that govern incinerators burning waste types No. V and No. VI, as well as very large incinerators such as municipal incinerators, usually require special design criteria which are not dealt with in this publication. A proponent planning to operate very large or special use incinerators or incinerators burning waste types V & VI should contact the Department of Environment to discuss these plans.

Any new ideas or incinerator designs that fulfill the requirements of best practical technology will be given consideration. These guidelines are not intended to restrict improvements in the state-of-the-art design of incineration.

## 1.4 Provision for Updating

As the "state-of-the-art" advances for incineration and practical observations provide more information, these guidelines will be updated accordingly.

## 2. INCINERATION TERMINOLOGY AND DEFINITIONS

### 2.1 Terminology and Definitions

In these guidelines:

**"air contaminant"** means any solid, liquid or gas, or combination of any of them in the atmosphere, which results directly or indirectly from the activities of man;

**"Air pollution"** means

(i) the presence in the atmosphere of any air contaminant in excess of the permissible concentration prescribed in the regulations for that contaminant, or

(ii) the presence in the atmosphere of any air contaminant having an offensive odour, regardless of its concentration in the atmosphere;

**"theoretical air"** means the exact amount of air required to supply oxygen for complete combustion of a given quantity of a specific fuel;

**"excess air"** means the air remaining in the flue gas after a fuel has been completely burned, or that air supplied in addition to the theoretical quantity;

**"overfire air"** means any air supplied through or adjacent to the fuel bed that is controlled (forced or induced) with respect to quantity and direction and for the purpose of promoting combustion of the combustible materials in the fuel bed;

**"underfire air"** means any air supplied beneath the grate and passing through the fuel bed that is controlled (forced or induced) with respect to quantity and direction;

**"secondary air"** means air introduced into the secondary mixing or after burner section of the incinerator to aid in gaseous-phase combustion;[1]

**"auxiliary fuel"** means fuel burned to assist the combustion process for the purpose of preheating the incinerator or drying and igniting the solid waste and maintaining adequate temperatures when waste combustion is not self-supporting;[2]

**"auxiliary burner"** means a burner firing auxiliary fuel;

**"primary auxiliary burner"** means an auxiliary burner installed to assist with the primary combustion process;[3]

**"secondary auxiliary burner"** means an auxiliary burner installed in the secondary chamber to ensure complete combustion and to reduce smoke and odour by making the incinerator products pass through a flame. Such burners are commonly called afterburners;

**"breeching"** means passages conducting the flue gases from the incinerator exit to the stack;

**"burning period"** means the duration of that part of the operating cycle, from ignition of waste to burnout, during which burning of the waste charged is in progress;[4]

**"burning rate"** means the mass of waste incinerated during a burning period divided by the duration of the burning period (kg/hr);

**"burnout"** means the effective completion of combustion of the charged waste in the incinerator;

**"charge per cycle"** means the mass of waste charged to the incinerator per operating cycle;

**"damper"** means a manual or automatic device used to regulate the rate of flow of gases through the incinerator;

**"barometric damper"** means a hinged, or pivoted, balanced plate normally installed so as to admit air to the breeching, flue connection or stack, thereby automatically maintaining a constant draft in the incinerator;[5]

**"butterfly damper"** means an adjustable, privoted plate installed in the breeching;

**"guillotine damper"** means an adjustable plate, counterbalanced for easier operation, normally installed vertically in the breeching;

**"sliding damper"** means an adjustable plate normally installed in a duct, breeching, flue connection or stack and arranged to move horizontally across the duct, breeching, flue connection or stack;

**"draft"** means the difference in a static pressure between the incinerator chamber and the atmosphere — positive when the chamber pressure is above atmospheric pressure, and negative when it is below atmospheric pressure;

**"forced draft"** means the positive pressure generated by a fan or blower supplying air to the incinerator;

**"induced draft"** means the negative pressure generated by a fan, blower or ejector located between the incinerator and the stack;

**"natural draft"** means the negative pressure created by the difference in density between the hot flue gases and the atmosphere;

**"batch incineration"** means that waste is charged to the incinerator in batches, and each batch is allowed to finish burning before more waste is added;

**"continuous incineration"** means that, after start-up of operation, waste is charged to the incinerator continuously or periodically in such a manner as to maintain an effectively steady rate of incineration;

**"existing incinerator"** means any incinerator installed prior to January 1, 1983;

**"new incinerator"** means any incinerator installed on or after January 1, 1983;

**"controlled air incinerator"** means an incinerator with an airtight ignition chamber, compact afterburner and a forced or induced draft. A controlled air incinerator is either a forced air incinerator or a starved air incinerator;

**"multiple chambered incinerator"** means an incinerator consisting of three refractory lined chambers or zones connected by gas passages, or ducts, and designed in such a manner as to provide both overfire and underfire combustion air;

**"single chambered incinerator"** means an incinerator with one refractory-lined primary combustion chamber into which waste is charged and burned and combustion products are emitted directly into a stack;

**"ignition chamber"** means the chamber into which the refuse is charged and burned. It is commonly referred to as the primary combustion chamber;

**"observer"** means a visible emission reader who is the holder of a Certificate of Proficiency issued under section 2(1)k of the Clean Air Act;

"**opacity**" means the degree (determined by an observer) to which visible emissions obstruct the passage of light and obscure the view of an object in the background;[6]

"**operator**" means the incinerator owner or agent of the owner having responsibility for the management of the incinerator;

"**operating cycle**" means the regular cycle of operation of the incinerator, from start-up to shut-down, in full time operation. It begins with start-up operations such as preheat, initial charging and ignition and concludes with burnout, cooling, residue removal and routine inspection and maintenance;

"**particulate matter**" means any material, except uncombined water, having definite physical boundaries at reference conditions;

"**residence time**" means the average time spent by gaseous products of combustion in the incinerator;

"**scrubber**" means auxiliary equipment designed to remove air contaminants from the products of combustion;

"**waste**" means any discarded or otherwise unwanted material predominantly composed of one or more of the materials classified in Table 1;

"**physical condition of waste**" means the physical configuration of the waste based on the waste classifications used in Table 1. Component parameters are the fractional volume, the bulk density and the state of mixing;

"**garbage**" means mixed animal and vegetable wastes resulting from restaurants, cafeterias, hotels, supermarkets, etc. It contains a moisture content of 30% to 70% and a minimum gross heating value of approx. 2300-6900 kJ/kg (see Table No. 1);

"**refuse**" means a mixture of rubbish and garbage (see Table No. 1) with a moisture content of 35% to 50% and a minimum gross heating value of approx. 9300-13900 kJ/kg (see Table No. 1);

"**rubbish**" means non-putrescible solid wastes, including ash, and consisting of both combustible and a maximum of 10% non-combustible wastes. It has a moisture content of up to 25% and a minimum gross heating value of approx. 15000 kJ/kg (see Table No. 1);

"**ultimate analysis**" means the analysis of the waste for its constituent elements (example; C, H, N, O, S,);

"**visible emission**" means any air contaminants which, when emitted into the atmosphere, can be detected by an observer but does not include an open smokeless flame;

## TABLE NO. 1
## CLASSIFICATION AND DESIGN DATA OF WASTES TO BE INCINERATED

| Type of Waste | Description | Principal Components | Approximate Composition % by Weight | Moisture Content % (Design Maximum) | (Average) Incombustible Solids % | KJ Value Per Kg. of Refuse as Fired (Design Minimum) | Required Minimum Burner Input (kw per Kg Waste) |
|---|---|---|---|---|---|---|---|
| I* | Rubbish | Combustible waste, paper, cartons, rags, wood scraps, floor sweepings; domestic, commercial industrial sources. | Rubbish 100% (garbage up to 20%) | 25% | 10% | 15000 | 0 |
| II* | Refuse | Rubbish and garbage; residential sources. | Rubbish 35-80% Garbage 65-20% | 50% | 7% | 10000 | 1.3 |
| III* | Garbage | Animal & vegetable wastes, restaurants, hotels, markets; institutional, commercial & club sources. | Garbage 100% (rubbish up to 35%) | 70% | 5% | 5815 | 1.9 |
| IV** | Animal solids & organic wastes. | Carcasses, organs, solid organic wastes; hospital, laboratory abbattoir, animal pound, and similar sources. | 100% Animal & human tissue | 62% | 9% | 2300 | 7.5 |
| V | Gaseous liquid or semi-liquid wastes. | Industrial process wastes (tars, paints, solvents, fumes). | Variable | Dependent on predominant components. | Must be determined by wastes survey. | | Must be determined by wastes survey. |
| VI | Semi-solid & solid. | Combustibles requiring hearth, retort, or grate burning equipment (rubbish, plastics, wood wastes). | Variable | Dependent on predominant components. | Must be determined by wastes survey. | | Must be determined by wastes survey. |

*The above figures are recommended for use in computing heat release, burning rate, velocity and other details of incinerator design.
**Type IV wastes require a "heated hearth" type of incinerator.

# 3. GENERAL INCINERATION DESIGNS AND COMPARISONS

## 3.1 Incineration Process

Basically, an incinerator is a furnace in which waste material is burned. The waste is usually ignited by an auxiliary fuel burner, and the products of the reaction are ash and hot flue gases containing pollutants. The combustion principle involves three parameters: temperature, time and turbulence.

A minimum temperature is required to volatilize the waste and drive off any moisture. Time is required for sufficient mixing of the reactants with air and for the reaction to come to completion. Turbulence is necessary to prevent separation or stratification of the combustion gases so as to ensure that the reactants come into contact and the oxidation reactions proceed to completion. These three variables are essential to satisfactory solid waste combustion.

## 3.2 Principles of Solid-Waste Combustion

The fundamental principles of solid-waste combustion that apply to incineration are:

(1) air and fuel must be in proper proportion;

(2) air and fuel, especially combustion gases, must be mixed adequately;

(3) temperatures must be sufficient for ignition of both the solid fuel and the gaseous components; and

(4) furnace volumes must be large enough to provide the retention time required for complete combustion.[1]

## 3.3 Types of Incinerators

Several types of incinerators available for waste combustion are:

(1) single chambered incinerators;

(2) multiple chambered incinerators;

(3) controlled air incinerators,
  (a) starved air incinerator and
  (b) forced air incinerator.

These units are most often used to burn waste types I-IV (see Table 1) and are covered by these guidelines.

The larger or special use incinerators include:

(1) fluidized bed;

(2) rotary kiln;

(3) open pit (forced air);

(4) liquid injection;

(5) multiple hearth; and

(6) coincineration.[7]

These types of incinerators are not included in this guideline.

### 3.4 Design Characteristics of Single Chambered, Multiple Chambered and Controlled Air Incinerators.

Three incinerator designs are covered by these guidelines. Each of the designs have the following unique characteristics:

(1) Single Chambered Incinerators (see Fig. 1)

- These units are generally limited to incinerating Type I wastes.
- The air supply to these units should have provisions to allow the theoretical air plus 50% to 100% excess air.
- Auxiliary fuel burners are generally absent from single chambered incinerators.

(2) Multiple Chambered Incinerators (see Fig. 2 and Fig. 3)

- These units are widely accepted. Two basic designs of multiple chambered incinerators are:

  (a) The retort type of incinerator, which is characterized by the following features:

  (i) The arrangements of the chambers cause the combustion gases to flow through 90° turns in both horizontal and vertical directions.

  (ii) The return flow of the gases permits the use of a common wall between the primary and secondary combustion chambers.

  (iii) This unit comes in smaller capacities (45-450 kg/h).[8]

  (b) The in-line type of incinerator exhibits the following features:

  (i) The flow of combustion gas is straight through the incinerator with 90° turns only in the vertical direction.

  (ii) The in-line arrangement is easily adaptable to installations that require separated spacing of the chambers for operating, maintenance or other reasons.

  (iii) This unit is common in facilities which require a large capacity (greater than 450 kg/h).[8]

- Air supplied for multipled chambered incinerators provide theoretical air and between 200-400% excess air. The combustion air distribution is approximately:

  (i) 70% of the total air (stoichiometric plus excess) required through overfire air ports.

  (ii) 10% of the total air required through underfire air ports.

  (iii) 20% of the total air required through the mixing chamber air ports.

- Multiple chambered incinerators have been used extensively in numerous facilities, but a more recent development in incineration appears to be causing replacement of these units. Pyrolysis, or controlled air incineration, was not very common prior to the 1970's, but now it is a widely accepted incineration process.

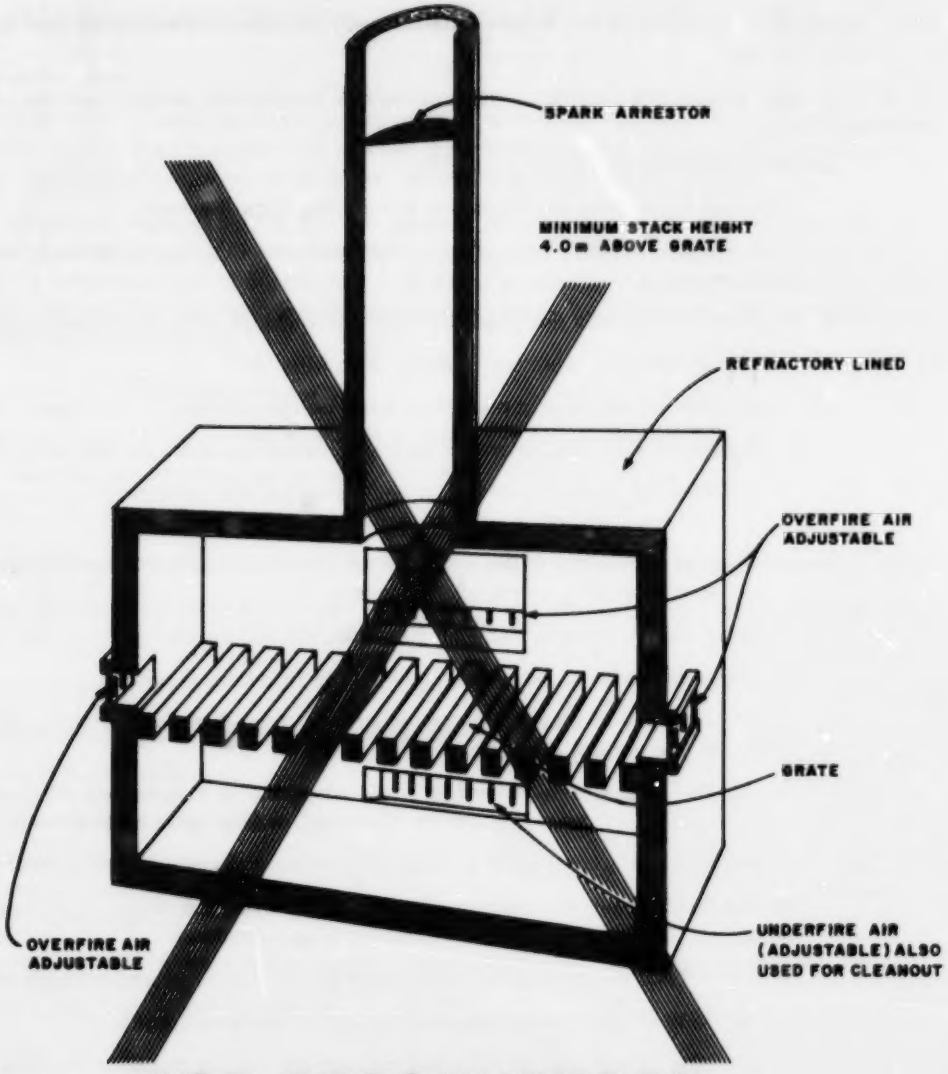
(3) Controlled Air Incinerators (see Fig. 4)

- These units have three basic components:

  (a) The airtight primary combustion chamber where pyrolysis gases are formed.

  (b) The secondary combustion chamber contains an afterburner to ensure complete combustion of all flue gases.

  (c) The stack is designed to provide adequate dispersion of air contaminants in the flue gas.




**NOT RECOMMENDED**

**HOWEVER FOR SMALL AMOUNTS OF TYPE I WASTE ONLY, APPROVAL MAY BE OBTAINED**

**Figure 1. Simplified schematic of a single chambered incinerator.**

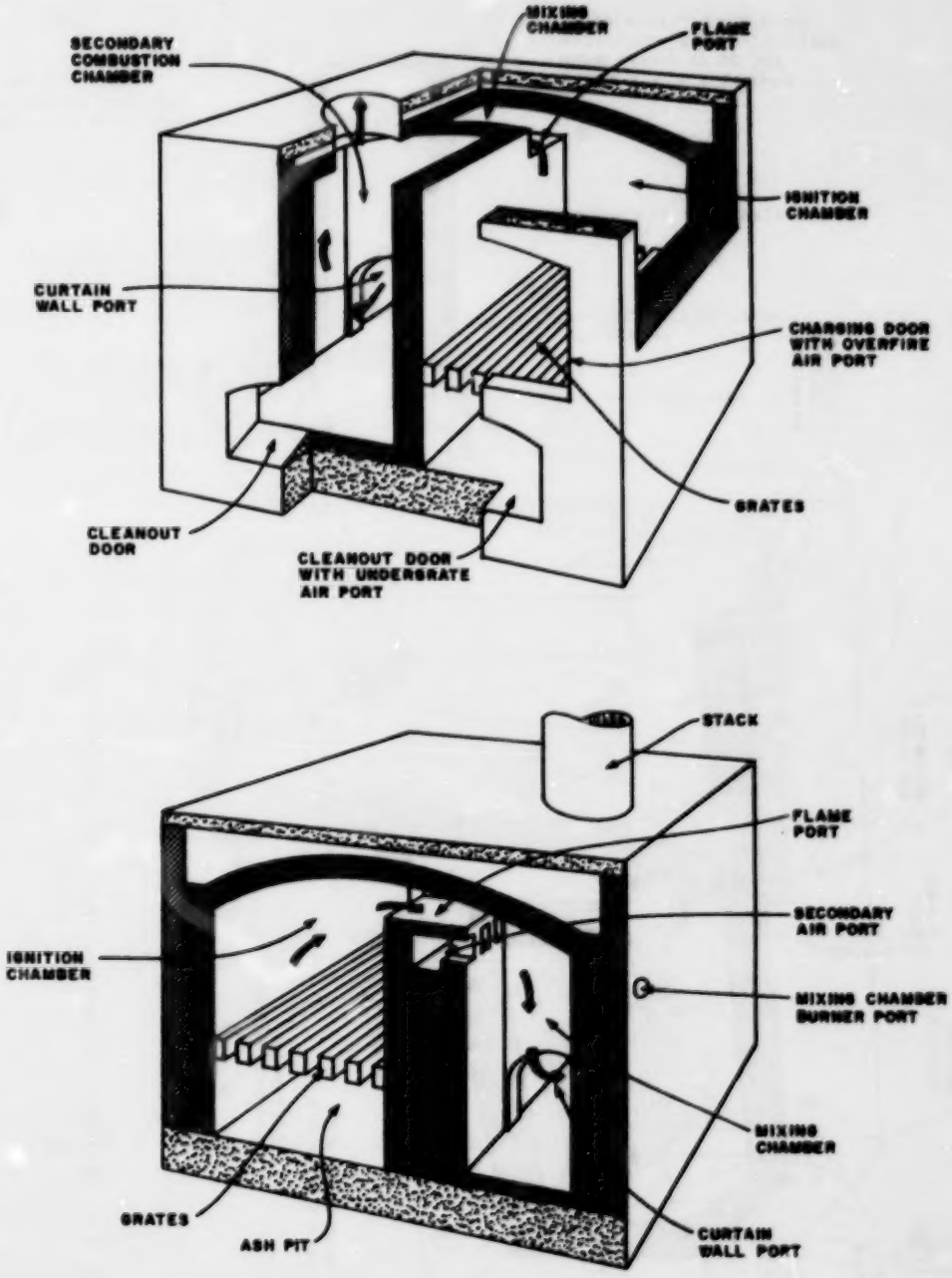



**Figure 2. Multiple chamber (retort) incinerator[8].**

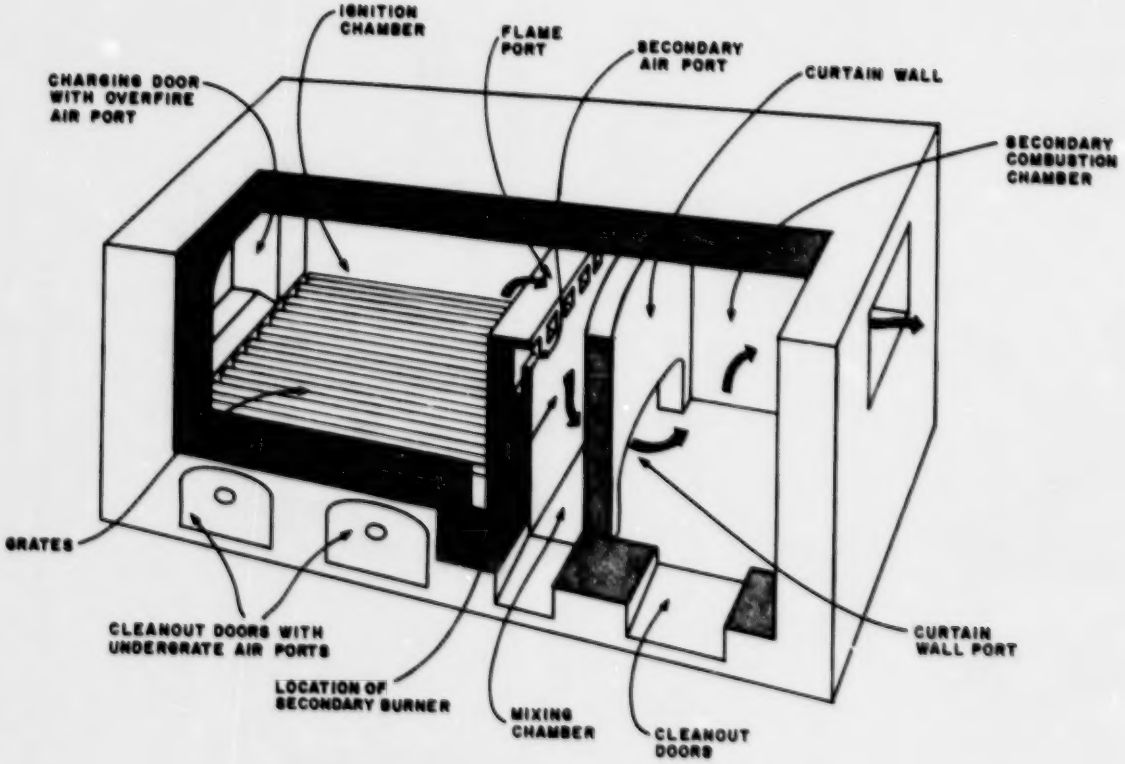



Figure 3. Multiple chamber (in-line) incinerator[8].

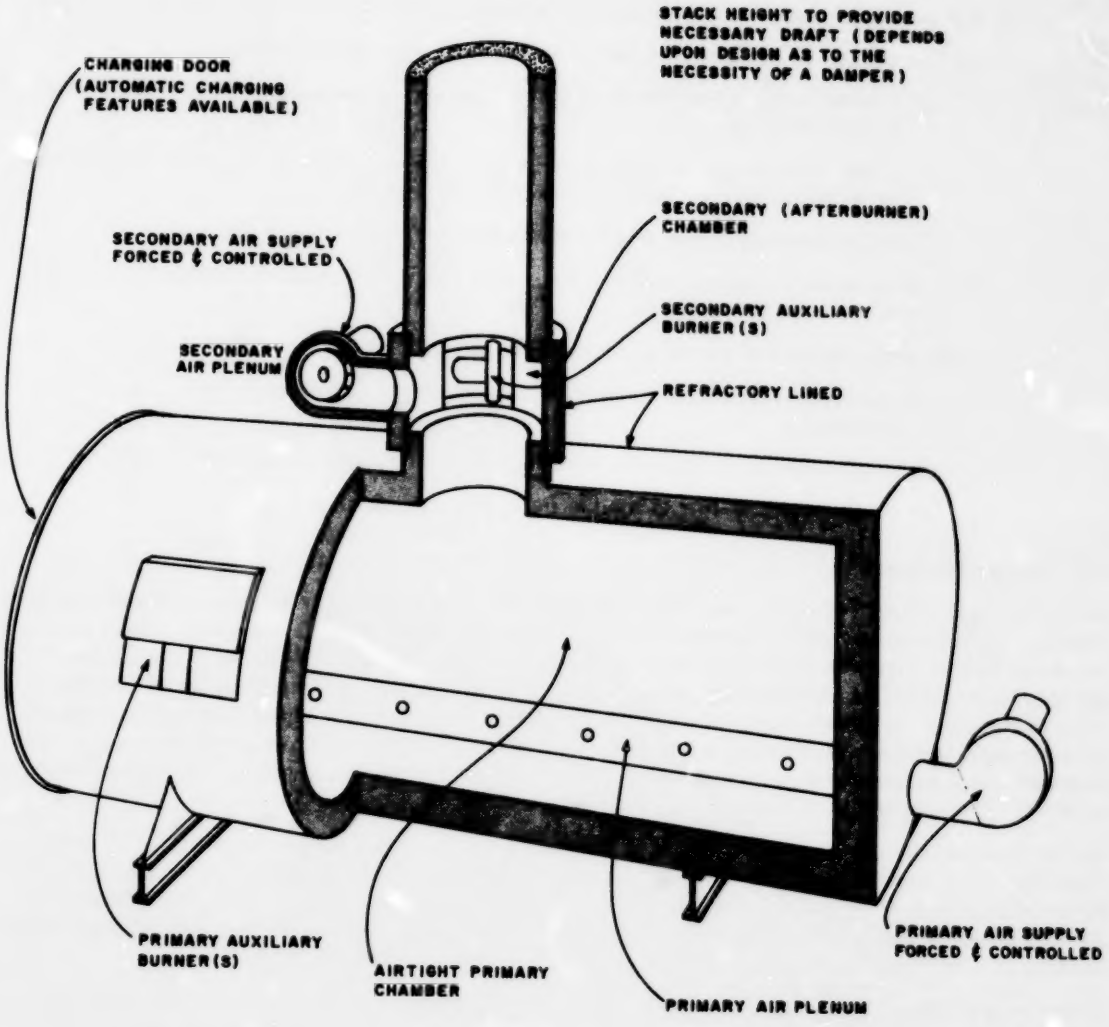

STACK HEIGHT TO PROVIDE NECESSARY DRAFT (DEPENDS UPON DESIGN AS TO THE NECESSITY OF A DAMPER)
CHARGING DOOR (AUTOMATIC CHARGING FEATURES AVAILABLE)
SECONDARY (AFTERBURNER) CHAMBER
SECONDARY AIR SUPPLY FORCED & CONTROLLED
SECONDARY AUXILIARY BURNER (S)
SECONDARY AIR PLENUM
REFRACTORY LINED
PRIMARY AUXILIARY BURNER (S)
AIRTIGHT PRIMARY CHAMBER
PRIMARY AIR PLENUM
PRIMARY AIR SUPPLY FORCED & CONTROLLED

Figure 4. Controlled air incinerator.

Alberta
ENVIRONMENT
Standards & Approvals Division
Air Quality Branch

- The two major designs of controlled air incinerators are:

  (a) The starved air incinerator in which the air supply for the incinerator

    (i) provides a starved air condition or less than theoretical quantity of air in the primary ignition chamber,

    (ii) provides an excess air quantity in the secondary or afterburner section (total excess air in the afterburner varies between 200-400%),[6] and

    (iii) has an auxiliary burner located in the primary combustion chamber.

  (b) The forced air incinerator, which is a variation between the single chambered incinerator and the starved air incinerator.

- Basic characteristics of forced air incinerators are:

    (i) combustion air is supplied by a fan through small holes in the ignition chamber floor or walls;

    (ii) combustion air is controlled by a manual or automatic device; and

    (iii) an auxiliary burner is located in the primary combustion chamber.

### 3.5 Design Comparison

The fundamental difference between two of the most common incinerator designs (controlled air and multiple chamber) lies in the amount of combustion air supplied and the manner in which it is admitted. Each kilogram of refuse requires a theoretical quantity of air to combine with the combustibles in the waste in order for combustion to occur. To illustrate this point, 5.1 kg. of air is required for each kilogram of cellulose in order to complete the combustion process. If one kilogram of cellulose was burned with no heat losses, the combustion products would reach a temperature of 1930°C.[6] This temperature would damage ignition chamber walls because normally ignition chambers are designed for temperatures in the range of 540°C to 980°C. The temperature is reduced by supplying a controlled amount of excess air.

Fig. 5 illustrates how the temperature of the combustion products varies with the combustion air supply. From Fig. 5 it is observed that the gaseous products of combustion reach a maximum temperature at 0 percent excess air or at stoichiometric conditions. With less than stoichiometric air, the temperature decreases due to incomplete combustion of the refuse. With more than stoichiometric air, the temperature decreases because of dilution with excess air.

Using this knowledge, the gas temperatures in the ignition chambers can be kept within the desired range. Multiple chambered and forced air incinerators control temperatures by using the excess air approach while the starved air incinerator starves the combustion reaction by using less than the stoichiometric quantity of air. By starving the reaction, pyrolysis occurs: the volatile fraction of the refuse is gasified and subsequently mixed with excess air supplied in the afterburner. The char portion of the refuse burns in the ignition chamber and supplies heat for the pyrolysis process. The highly volatile pyrolysis gas is completely combusted in the afterburner and, because of this staged combustion, energy from the waste is released throughout the incinerator. The need for cooling air in the ignition chamber is eliminated, and the after burner fuel requirements are decreased.[6]

In summary, single chambered, multiple chambered and forced air incinerators all use excess air to lower and maintain temperatures in the combustion chamber. Controlled air incinerators use the starved air principle to protect the refractory from excessive heat buildup.

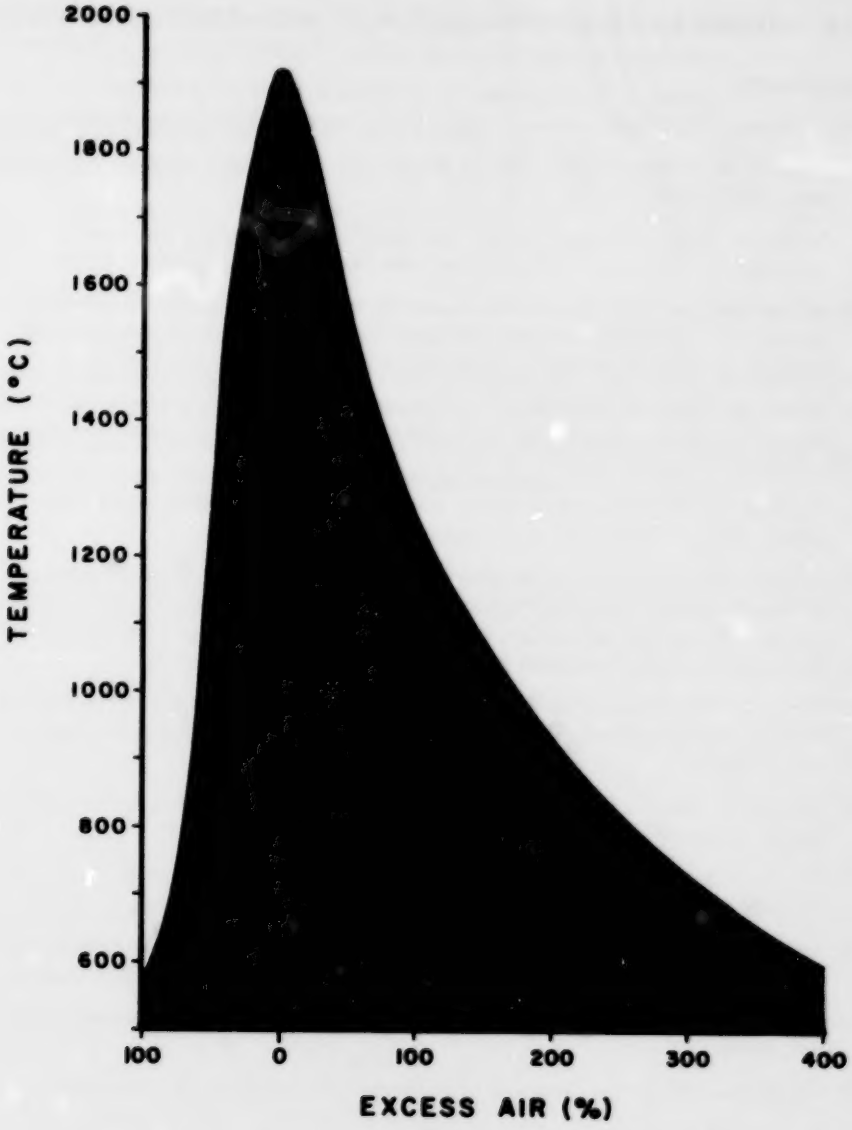



Figure 5. No heat loss (adiabatic) temperatures of cellulose combustion with excess air variations[3].

Alberta
ENVIRONMENT
Standards & Approvals Division
Air Quality Branch

# 4. GENERAL REQUIREMENTS FOR INCINERATOR APPROVAL

## 4.1 Acceptability

In order to be acceptable, all incinerators constructed or installed should meet the following requirements:

(1) Multiple chambered, forced air or starved air incinerators may be approved for use in all areas of Alberta.

(2) In urban areas with populations less than 50,000, single chambered incinerators may be approved for the consumption of up to 50 kg./h of Type I waste.

(3) All incinerators must be provided with an identification plate, permanently attached in an obvious and accessible location. The plate shall bear the manufacturer's name, model number, capacity rating and auxiliary fuel burner ratings.

(4) Incinerators burning other than Type I waste must be equipped with auxiliary burners and sized to suit the type of refuse being burned. However, controlled air incinerators should always have an auxiliary burner.

(5) Auxiliary burners installed on incinerators shall comply with regulations established by Alberta Labor, General Safety Services Division.[9]

(6) The manufacturer shall provide adequate instructions and drawings for operating the incinerator with wastes of the specified categories. The instructions shall include the procedures for start-up, normal operation, shutdown, care and maintenance. A copy of the instructions shall be posted near the incinerator and shall be readily available to the operator.

(7) If the incinerator is installed in a room, the room should conform to "The Alberta Building Code 1981".[9] The incinerator room must be provided with an adequate air supply to ensure proper combustion.

(8) Dampers or positive manual draft controls shall be provided on all incinerators. Automatic draft control may be required.

(9) Clean-out doors or entrances shall be provided so that all parts of the incinerator, including air nozzles, may be cleaned.

(10) Adequate flue gas scrubbers, fly ash collectors, draft gauges, smoke indicators and temperature indicators may be required where deemed necessary by the Division of Standards and Approvals.

(11) All incinerators should be lined with an appropriate refractory material that meets pertinent ASTM Standards.

(12) Incinerators should be designed to minimize the possibility of overloading.

(13) No flue fed incinerators will be approved.

(14) All incinerator stacks should be designed to provide:
   (a) adequate draft for proper operation of the incinerator,
   (b) adequate dispersion of all air contaminants to meet acceptable ground level concentrations (dispersion models are available in "Guidelines for Plume Dispersion Calculations" May 1980, which is a publication of Alberta Environment, Standards & Approvals Division),
   (c) compliance with "Standard on Incinerators, Waste and Liner Handling Systems and Equipment (NFPA No. 82-1977),[10] and
   (d) adequate separation distances between the incinerator stack and any building air intakes as determined by the Alberta Building Code 1981, NFPA No. 82-1977 and the Alberta Environment Publication "Guidelines for Plume Dispersion Calculations".

(15) Incinerators should be sized by estimating the amount of waste to be consumed (see Table 2) or by conducting a survey to determine the amount of waste to be handled.

(16) The maximum burning period for an incinerator will generally be as follows:

(a) industrial (2 or more shifts/day) — 7 hours/shift;

(c) commercial and industrial (1 shift) — 6 hours/day;

(c) institutions and hotels — 6 hours/day;

(d) schools, office buildings, stores, banks, etc. — 4 hours/day;

(e) heat recovery facilities with automatic ash removal and charging may be operated continuously.

Table 3 and 4 indicate typical densities of refuse and the volumes of some common waste collectors.

(17) For some applications, such as hospital wastes, it is recommended that only the most efficient type of incinerators be used (i.e. the controlled air designs).

## TABLE NO. 2
## QUANTITIES OF WASTE PRODUCED
### Sizing and Classification Guide

This Table shows values to be used in sizing incinerators according to classification and type of building.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Classification** | **Building Types** | **Types of Waste** | **Burning Time-hrs.** | **Approximate Quantities of Waste Produced/day** |
| Industrial | plants | V, VI | 6* | survey must be made |
| | factories | I, II, III V, VI | 6* | survey must be made |
| | warehouses | I, II, III V, VI | 6* | 1 kg/10m² |
| Commercial Buildings | office buildings | I | 4 | .5 kg/10m² |
| | department stores | I, II | 6 | 2 kg/10m² |
| | shopping centres | I, II | 6 | study of plans or survey required |
| | supermarkets | I, II | 6 | 4.5 kg/10m² |
| | restaurants | II, III | 6 | 1 kg/meal |
| | drug stores | I, II | 4 | 2.5 kg/10m² |
| | banks | I | 4 | study of plans or survey required |
| | food markets | II, III | 6 | 2.5 kg/3m² |
| | cafeterias | II, III | 6 | .2 - .3 kg/meal |
| Residential | apartment bldgs. | II | 3 | 2.5 kg/basic suite plan .5 kg/bedroom |
| Schools | elementary schools | I, II | 4 | 4.5 kg/room & .1 kg/pupil |
| | high schools | I, II | 4 | 3.5 kg/room & .1 kg/pupil |
| | universities | I, II, III, IV | 4 | survey required |
| Institutions | hospitals | II, III, IV | 6 | 7 kg/bed (500 beds or over) 4 kg/bed (less than 500 beds) |
| | nurses resid. | I, II | 3 | 1.5 kg/person |
| | home for aged | I, II | 3 | 1.5 kg/person |
| | rest homes | I, II | 3 | 1.5 kg/person |
| Hotels | hotels – 1st class | II | 6 | 1.5 kg/room & 1 kg/meal |
| | hotels – med. class | II | 6 | 1 kg/room & .5 kg/meal |
| | motels | I | 6 | 1 kg/room |
| | trailer camps | II | 6 | 3.5 kg/trailer |
| Miscellaneous | vet. hospitals | II, IV | 6 | study of plans or survey required |
| | Municipalities | | – | 2 – 2.5 kg/capita survey required |

*If two or more shifts – 7 hours/shift.

## TABLE NO. 3
## TYPICAL DENSITIES OF REFUSE

| | |
|---|---|
| Type I Waste | 160 kg/m³ |
| Type II Waste | 320 kg/m³ |
| Type III Waste | 560 kg/m³ |
| Type IV Waste | 880 kg/m³ |
| Garbage @ 60% moisture | 320 kg/m³ |
| Garbage @ 70% moisture | 640 kg/m³ |
| Garbage @ 80% moisture | 720 kg/m³ |
| Magazines & Packaged Paper | 320 to 800 kg/m³ |
| Loose Paper | 80 to 112 kg/m³ |
| Scrap Wood and Sawdust | 190 to 240 kg/m³ |
| Sawdust | 320 kg/m³ |
| Sawdust (impregnated) | 480 kg/m³ |

SOURCE: REFERENCE 5

## TABLE 4
## VOLUME OF SOME COMMON WASTE COLLECTORS

| | |
|---|---|
| Garbage Can (.46 m X .61 m) | .10 m³ |
| Garbage Can (.41 m X .56 m) | .06 m³ |
| Barrel | .11 m³ |
| Oil Drum (227 l) | .227 m³ |

SOURCE: REFERENCE 5

# 5. INCINERATOR EMISSION GUIDELINES

## 5.1 General

All air contaminant emissions from incinerators should be limited so that their effect on the ambient air does not

- endanger the health, safety or welfare of any individual,
- interfere with normal enjoyment of life or property,
- endanger the health of animal life, and
- cause damage to plant life or to property.

Most incinerators with adequate flue gas treatment will meet all of the specific requirements of these guidelines, provided they are designed and operated properly.[2]

## 5.2 Specific Emission Limits

The specific emission limits for incinerators are as follows:

(1) Visible Emissions

(a) No person should operate an existing incinerator which produces visible emissions in excess of an opacity of 40% averaged over a period of six consecutive minutes.

(b) No person should install or operate a new incinerator which produces visible emissions in excess of an opacity of 20% averaged over a period of six consecutive minutes.

(2) Particulate Emissions

Refuse incinerators with a capacity of

(a) greater than 220 kg/h should be designed and operated in a manner which results in the concentration of particulates in the flue gas not exceeding 0.2 kilogram/1000 kilogram of flue gas.

(b) less than 220 kg/h should be designed and operated in a manner which results in the concentration of particulates in the flue gas not exceeding 0.6 kilogram/1000 kilogram of flue gas.

(3) Gaseous Emissions

(a) Hydrogen Chloride

(i) No person should operate an incinerator from which the contaminants discharged to the atmosphere contain hydrogen chloride in excess of 100 parts per million by volume (ppmv) on a dry basis and corrected to 50% excess air.[6]

(ii) Hydrogen chloride in the ambient air should not exceed 0.06 ppmv as a 1/2 hour average concentration because of the incinerator emissions.[11]

(b) Sulphur Dioxide

(i) No person should operate an incinerator from which the contaminants discharged to the atmosphere contain sulphur dioxide in excess of 250 ppmv on a dry basis and corrected to 50% excess air.[6]

(ii) Sulphur dioxide in the ambient air should not exceed 0.17 ppmv as a one hour concentration because of emissions from an incinerator.

(c) Nitrogen Dioxide

(i) Nitrogen dioxide in the ambient air should not exceed 0.21 ppmv as a one hour concentration because of emissions from an incinerator.

*NOTE: In some special cases, such as large incinerators or sensitive locations, more stringent requirements may be applied.

# 6. ASSESSING INCINERATOR COMPLIANCE

## 6.1 Visible Emissions

The operator of any new incinerator should, within a period of 90 days commencing at initial start-up, operate the incinerator under normal conditions for one complete operating cycle so as to provide an observer the opportunity to monitor the emissions.

## 6.2 Particulate Emissions

The operator of any new incinerator should

(1) within a period of 90 days, commencing at initial start-up, survey the incinerator for particulate emissions as specified in Section 7 and provide the Director of Standards and Approvals a written report of the survey results, or

(2) provide the Director of Standards and Approvals with a written report of the results of a particulate emission survey conducted in accordance with Section 7 on an incinerator which is similiar in design, construction or operation to the new facility. The survey results must demonstrate to the Director of Standards and Approvals that the flue gases emitted from the incinerator will not contain particulate matter in excess of Section 5.

## 6.3 Gaseous Emissions

(1) Hydrogen Chloride

The operator of a new incinerator should, within a period of 90 days commencing at initial start-up, survey the incinerator for hydrogen chloride emissions as specified in Section 7 and provide the Director of Standards and Approvals with a written report of the survey results. The Director of Standards and Approvals may not require HCl testing and may consider the incinerator to be in compliance with Section 5 if the incinerator is not to be charged with halogenated material at a rate which exceeds .25% of the rated capacity of the incinerator.

(2) Sulphur Dioxide

The operator of a new incinerator should, within a perid of 90 days commencing at initial start-up, survey the incinerator for sulphur dioxide emissions as specified in Section 7 and provide the Director of Standards and Approvals with a written report of the survey results. The Director of Standards and Approvals may not require $SO_2$ testing and may consider the incinerator to be in compliance with Section 5 if the incinerator is not charged with sulphur containing compounds, such as rubber, at a rate in excess of 20% of the rated capacity of the incinerator.

# 7. INCINERATOR EMISSIONS TESTING

## 7.1 General Requirements

All emission tests to be used for assessing compliance should be conducted by reputable, properly trained personnel and witnessed by a representative of the Department of Environment or other regulatory agency such as EPA. During a compliance survey, the incinerator should be operated under conditions representative of normal operation or under any other conditions as specified by the Director of Standards and Approvals.

Incinerators which operate in a single batch mode should be surveyed at the rate of one survey per operating cycle, and the survey should commence immediately following ignition of the waste. The survey shall consist of three tests all conducted in accordance with Stack Sampling Code (SSC-1/76). Each test shall be a minimum of one hour duration. (There needs to be a certain amount of time between tests to clean and/or change equipment. Therefore, one test (one hour long) per hour is not possible. This should be considered when establishing the duration of the burning period.) If the operating cycle is shorter than the survey period (typically 3 hours), at least one test during the 60 minute period immediately following ignition of waste should be done.

Incinerators which operate continuously should be surveyed at the rate of one test per hour for the complete operating cycle or until a complete survey has been conducted as set out in SSC-1/76. Testing should commence immediately following ignition of the waste.

## 7.2 Visible Emissions

The opacity of the visible emission should be measured by an observer in accordance with the Department of Environment Publication "Visible Emissions — A Manual For Training and Certification of Observers and Evaluation of Visible Emissions (VEE-2/77)" or other acceptable methods.

## 7.3 Particulate Emissions

The particulate emissions rate should be measured in accordance with the Alberta Environment Publication "Source Sampling Code Reference Methods for Source Sampling and Analysis of Particulates, Sulphur Oxides and Oxides of Nitrogen (SSC-1/76)" or other methods acceptable to the Director of Standards and Approvals.

## 7.4 Gaseous Emissions

(1) Hydrogen Chloride

The hydrogen chloride emission rate should be measured in accordance with the Alberta Environment Publication "Methods Manual for Chemical Analysis of Atmospheric Pollutants, 1978 Method No. 42525" and Alberta Environment Publication SSC-1/76. Special sampling techniques are normally required because of the corrosive nature of HCl in the flue gas (e.g., quartz lined sampling probes).

(2) Sulphur Dixoide:

The sulphur dioxide emission rate should be measured in accordance with Alberta Environment Publication SSC-1/76 or other methods acceptable to the Director of Standards and Approvals.

All stack or source emission surveys shall be reported in accordance with Alberta Environment Publication "Source Emission Survey Report Format (AMD 79-3)" or other methods acceptable to the Director of Standards and Approvals.

# 8. APPLICATION PROCEDURE FOR A PERMIT TO CONSTRUCT AND A LICENCE TO OPERATE

## 8.1 Permit Authority

Section 3(1)c of the Clean Air Act states "Subject to the regulations, no person shall commence or continue the construction of an incinerator other than an incinerator for a one-family dwelling, unless the Director of Standards and Approvals issues a permit for it."

## 8.2 Licence Authority

Section 4(1) of the Clean Air Act states "No person shall commence the operation or use of a plant, structure or thing to which section 3(1) applies unless he is the holder of a licence in respect of the plant, structure or thing."

## 8.3 Exemption of Oilfield Incinerators

Portable incinerators having a burning capacity of less than 90.7 kg/h that:

(1) are used to dispose of kitchen camp wastes from drilling and exploration sites, and

(2) are at a location for less than one year,

are exempt from requiring a permit or licence under the Clean Air Act.

## 8.4 General Requirements

Under the authority of the Clean Air Act, Revised Statutes of Alberta 1980 Chapter C-12, the requirements for obtaining permits and licences are:

(1) The operator must submit an application to the Department of environment, Standards and Approvals Division, Oxbridge Place, 9820 - 106 Street, Edmonton, Alberta T5K 2J6.

(2) The operator should use the application form provided in this publication (Appendix A) or obtain copies from the Director of Standards and Approvals.

(3) All the data requested on the application form should be supplied. If the data requested are not applicable to the incineration project, this should be noted.

(4) In addition to the schematics, drawings and blueprints indicated in the application form, it is usually necessary to include drawings or sketches of:

(a) the incinerator room floor plan with dimensions showing air ventilation and other equipment or structures in the same room; and

(b) the relationship of the incinerator stack to roof structures, air intakes, windows, balconies and neighbouring buildings.

(5) Small, packaged, "off-the-shelf" incinerators (burning waste type I-IV) quite often have a standard design which includes master drawings and specifications. If the master records are on file with the Department of Environment, it may not be necessary to include the detailed drawings and heat balance specifications for each separate application.

## (APPENDIX A)

## APPLICATION FORM FOR APPROVAL OF INCINERATOR INSTALLATION

DATE: _____

1. BUILDING OWNER NAME: _____
   ADDRESS: _____
   _____
2. INCINERATOR OPERATOR: _____ POSITION: _____
   PHONE NO: _____ ALT. CONTACT: _____
   ADDRESS: _____
3. INCINERATOR LOCATION ADDRESS: _____
   _____
4. INCINERATOR MANUFACTURER NAME: _____
   ADDRESS: _____
   REPRESENTATIVE: _____
5. APPLICATION IS FOR: PERMIT _____ AMENDMENT OF A PERMIT _____
   LICENCE _____ AMENDMENT OF A LICENCE _____
6. INSTALLATION DATE: _____
7. TYPE OF OPERATION: CONTINUOUS _____ INTERMITTENT _____
8. BUILDING TO BE SERVED (SEE TABLE 2): _____
   FLOOR AREA: _____
   NUMBER OF SUITES: _____ TRAILERS: _____
   PERSONS: _____ NUMBERS OF BEDS: _____
   ROOMS (SCHOOLS): _____
9. WASTE CLASSIFICATION (SEE TABLE NO. 1):
   (a) TYPE I _____ %
   (b) TYPE II _____ %
   (c) TYPE III _____ %
   (d) TYPE IV _____ %
   (e) OTHER WASTES (DESCRIBE) _____ %
10. QUANTITY OF WASTE INCINERATED _____ KG/DAY
    BURNING TIME _____ HR/DAY

11. INCINERATOR PARTICULARS:

MAKE: _____ MODEL NO: _____

TYPE: SINGLE CHAMBER _____ FORCED AIR _____

MULTIPLE CHAMBER _____ STARVED AIR _____

IS INCINERATOR NEW _____ EXISTING _____ REPLACEMENT _____

RATED CAPACITY: _____ KG/HR. OF TYPE: _____ WASTE

CHARGING METHOD: MANUAL _____ MECHANICAL _____

TYPE OF GRATE OR HEARTH: _____

GRATE OR HEARTH AREA: _____ SQ. METERS

TEMP. IN PRIMARY COMBUSTION CHAMBER DESIGN: _____ °C

METHOD OF DRAFT CONTROL: _____

RETENTION TIME OF GASES DOWNSTREAM OF FLAME FRONT: _____ SEC.

BAROMETRIC DAMPER: _____ SIZE: _____ OTHER DAMPER: _____

WHAT PROVISIONS HAVE BEEN MADE FOR FRESH AIR SUPPLY TO INCINERATOR ROOM?

_____

12. AUXILIARY HEAT (BURNERS)

TYPE _____ PRIMARY (IGNITION) _____ KW

SECONDARY (AFTERBURNER) _____ KW

OTHER _____

TIMER CYCLE _____ FUEL TO BE SUPPLIED _____

NAME & ADDRESS OF INSTALLER _____

TYPE OF FLAME FAILURE CONTROL _____

13. INCINERATOR STACK

SAMPLING PORTS PROVIDED _____

DIMENSIONS _____ DIAMETER _____ CM

HEIGHT ABOVE GRADE _____ M, HEIGHT ABOVE ROOF _____ M

DISTANCE FROM NEAREST BUILDING _____ M

HEIGHT OF NEAREST HIGHER BUILDING(S) _____ M

HEIGHT OF OTHER OBSTRUCTIONS _____ M

SPARK ARRESTOR _____

TYPE OF AIR POLLUTION CONTROL EQUIPMENT TO BE INSTALLED _____

_____

15. A DRAWING(S) SHALL BE SUPPLIED TO SUPPLEMENT THE ABOVE DATA AND TO SHOW THE INCINERATOR'S: _____ INTERNAL DIMENSIONS

_____ BURNER LOCATIONS

_____ CHARGING DOORS

_____ SIZE AND LOCATION OF TEST OPENINGS

_____ TEMPERATURE CONTROL

_____ TEMPERATURE RECORDING DEVICE

16. A COPY OF A STACK COMPLIANCE SURVEY SHALL BE SUPPLIED IF THE DEPARTMENT OF ENVIRONMENT DOES NOT HAVE THE APPROPRIATE STACK SURVEY FOR THE INCINERATOR ON FILE.

17. *NAME OF APPLICANT: _____

OFFICIAL TITLE: _____

POSTAL ADDRESS: _____

18. *SIGNATURE OF OPERATOR _____ DATE: _____

OFFICIAL TITLE: _____

POSTAL ADDRESS: _____

*The Clean Air Act and Regulations require that the party responsible for the operation of the incinerator be licensed, therefore, the signature must be that of the responsible operator or owner. The application may be made by an agent of the responsible owner or operator.

## REFERENCES


1. Corey, Richard C., ed. Principles and Practices of Incineration, Wiley – Interscience, 1969.

2. Fisheries and Environment Canada, Environmental Protection Service, "Air Pollution Guidelines Applicable to Incinerators at Federal Establishments" Regulations, Codes and Protocols Report EPS 1-EC-78-5.

3. Fisheries and Environment Canada, Environmental Protection Service, "Air Pollution Emissions and Control Technology; Packaged Incinerator" Economic and Technical Review Report EPS 3-AP-77-3.

4. Canadian Standards Association, "Incinerator Performance" CSA Standard Z103-1976.

5. Ontario Ministry of the Environment, Environmental Approvals Branch "Criteria for Incinerator Design and Operation", Revised June 1974.

6. Department of Fisheries and the Environment "Packaged Incinerators National Emission Guidelines" The Canada Gazette Part I, November 25, 1978.

7. Monsanto Research Corporation, Dayton Ohio, Engineering Handbook for Hazardous Waste Incineration, prepared for U.S. Environmental Protection Agency June 1981.

8. Danielson, John A., ed. Air Pollution Engineering Manual, V.S. Environmental Protection Agency, Publication No. AP40, May 1973.

9. Alberta Labor, General Safety Services Division "The Alberta Building Code 1981".

10. National Fire Protection Association "Standards on Incinerators, Waste and Liner Handling Systems and Equipment" NFPA82-1977.

11. Government of Ontario, Schedule 1 Revised Regulations of Ontario, 1970 amended to October 1978.